

ИММУНОГЛОБУЛИ НЫ

СТРОЕНИЕ И
СВОЙСТВА

Строение антител

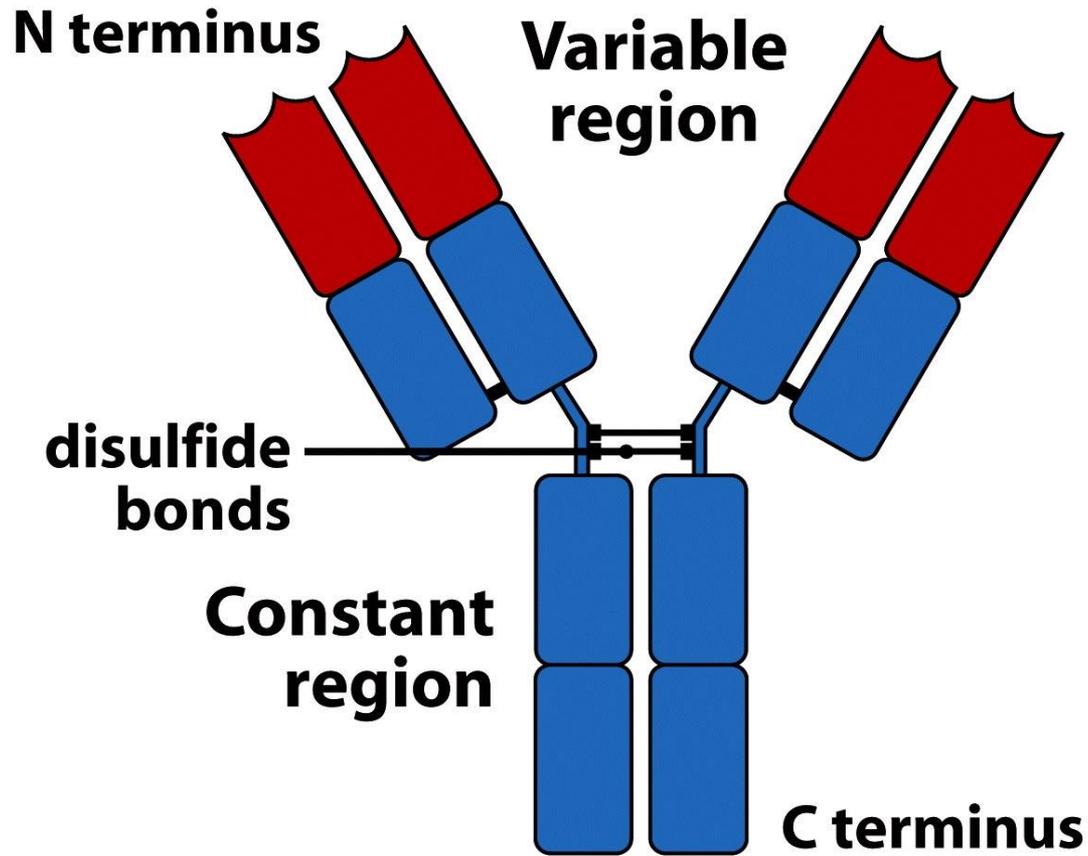


Figure 3-1c Immunobiology, 7ed. (© Garland Science 2008)

Строение антител

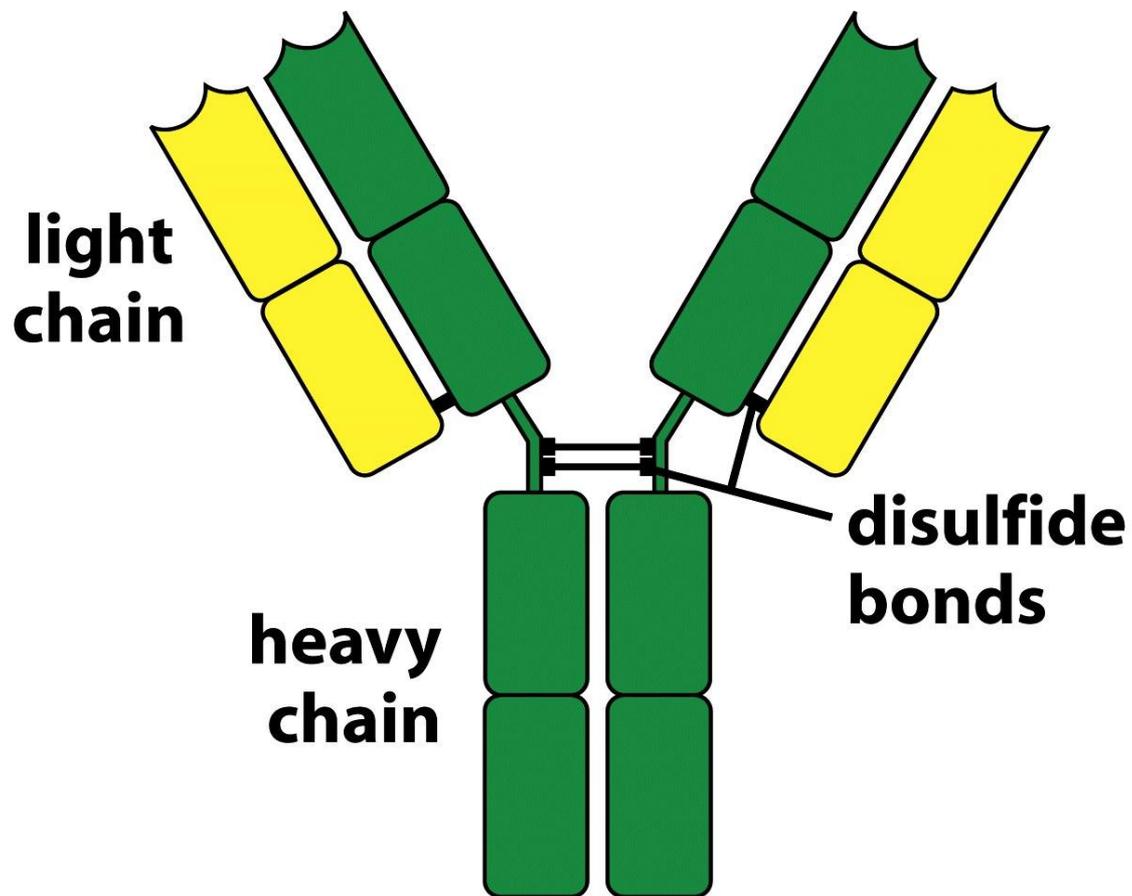


Figure 3-2 Immunobiology, 7ed. (© Garland Science 2008)

Действие протеолитических ферментов

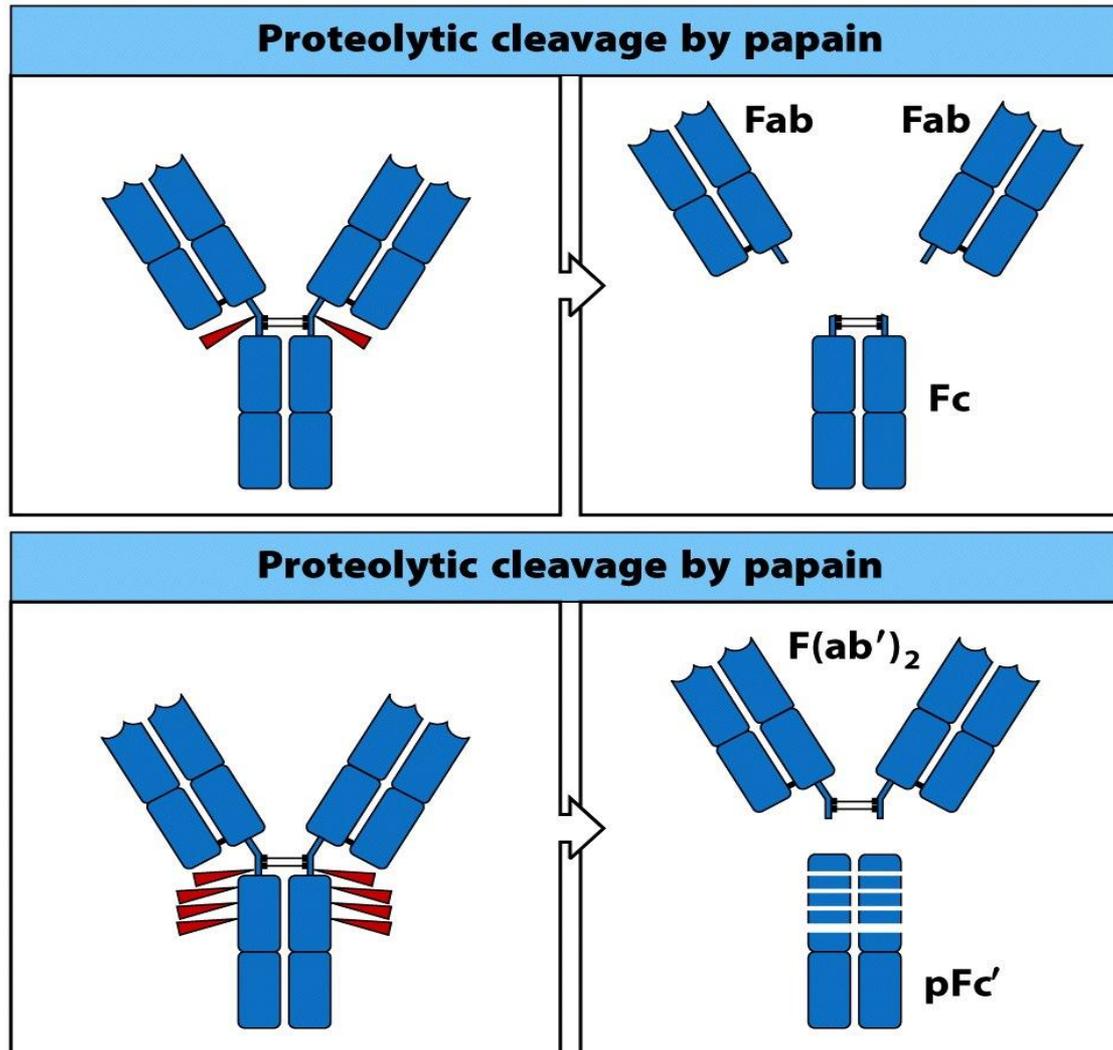
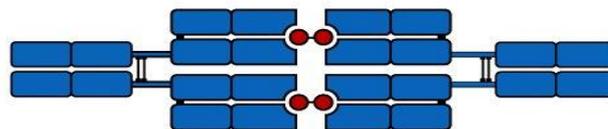


Figure 3-3 Immunobiology, 7ed. (© Garland Science 2008)

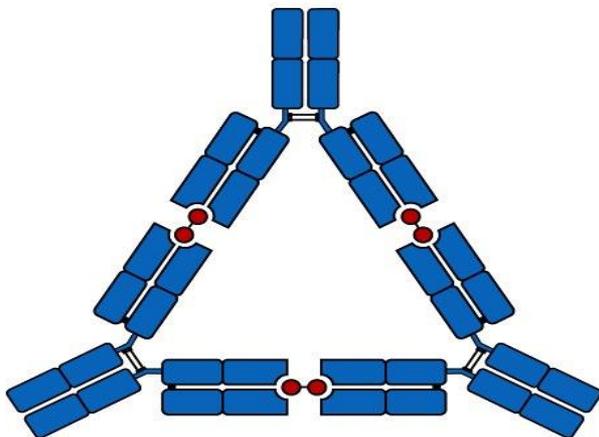
Шарнирная область молекул антител



Angle between arms is 0°



Angle between arms is 60°



Angle between arms is 90°

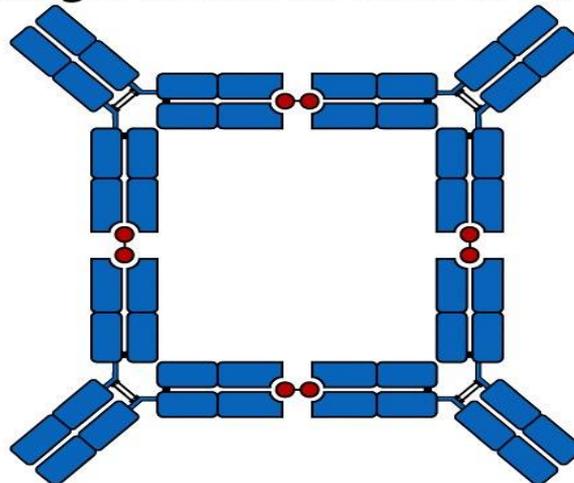


Figure 3-4 Immunobiology, 7ed. (© Garland Science 2008)

Силы, обеспечивающие связывание АГ-АТ

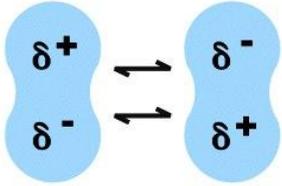
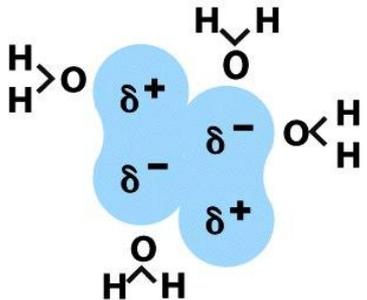
Noncovalent forces	Origin	
Electrostatic forces	Attraction between opposite charges	$-\overset{\oplus}{\text{NH}}_3 \quad \overset{\ominus}{\text{OOC}}-$
Hydrogen bonds	Hydrogen shared between electronegative atoms (N,O)	$\begin{array}{c} \diagup \text{N} - \text{H} \cdots \text{O} = \text{C} \diagdown \\ \delta^- \quad \delta^+ \quad \delta^- \end{array}$
Van der Waals forces	Fluctuations in electron clouds around molecules oppositely polarize neighboring atoms	
Hydrophobic forces	Hydrophobic groups interact unfavorably with water and tend to pack together to exclude water molecules. The attraction also involves van der Waals forces	

Figure 3-9 Immunobiology, 7ed. (© Garland Science 2008)

Сходство структуры Fab-фрагмента и Т-клеточного рецептора

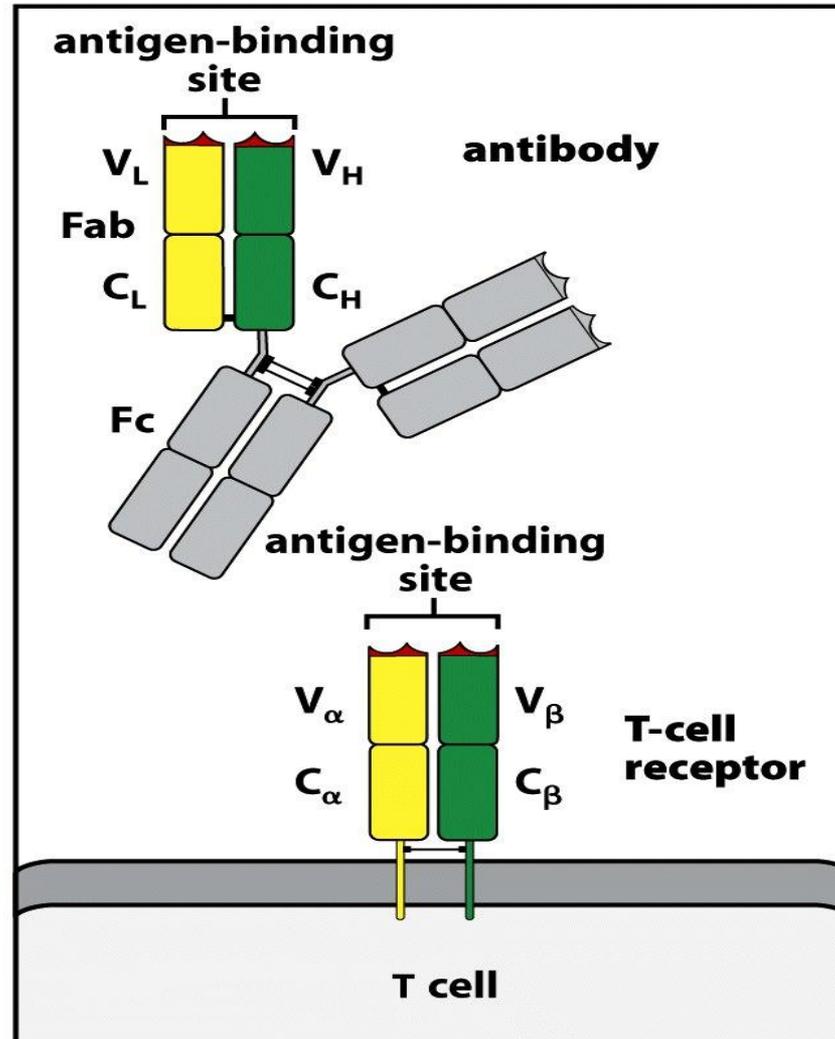


Figure 3-11 Immunobiology, 7ed. (© Garland Science 2008)

Свойства иммуноглобулинов

Функциональная активность	IgM	IgD	IgG1	IgG2	IgG3	IgG4	IgA	IgE
Нейтрализация	+	-	++	++	++	++	++	-
Опсонозация	+	-	+++	*	++	+	+	-
Сенсибилизация NK-клеток	-	-	++	-	++	-	-	-
Сенсибилизация тучных клеток	-	-	-	-	-	-	-	+++
Активация системы комплемента	+++	-	++	+	+++	-	+	-
Транспорт через эпителий	+	-	-	-	-	-	+++ димер	-
Транспорт через плаценту	-	-	+++	+	++	+/-	-	-
Содержание в сыворотке (мг /мл)	1,5	0,04	9	3	1	0,5	2,1	$3 \cdot 10^{-3}$
Присутствие в экстраваскулярном пространстве	+/-	-	+++	+++	+++	+++	++ мономер	+

Классы и субклассы ИММУНОГЛОБУЛИНОВ

	Immunoglobulin								
	IgG1	IgG2	IgG3	IgG4	IgM	IgA1	IgA2	IgD	IgE
Heavy chain	γ_1	γ_2	γ_3	γ_4	μ	α_1	α_2	δ	ϵ
Molecular weight (kDa)	146	146	165	146	970	160	160	184	188
Serum level (mean adult mg ml⁻¹)	9	3	1	0.5	1.5	3.0	0.5	0.03	5×10^{-5}
Half-life in serum (days)	21	20	7	21	10	6	6	3	2
Classical pathway of complement activation	++	+	+++	-	++++	-	-	-	-
Alternative pathway of complement activation	-	-	-	-	-	+	-	-	-
Placental transfer	+++	+	++	-/+	-	-	-	-	-
Binding to macrophage and phagocyte Fc receptors	+	-	+	-/+	-	+	+	-	+
High-affinity binding to mast cells and basophils	-	-	-	-	-	-	-	-	+++
Reactivity with staphylococcal Protein A	+	+	-/+	+	-	-	-	-	-

Figure 4-16 Immunobiology, 7ed. (© Garland Science 2008)

Классы и субклассы ИММУНОГЛОБУЛИНОВ

Functional activity	IgM	IgD	IgG1	IgG2	IgG3	IgG4	IgA	IgE
Neutralization	+	-	++	++	++	++	++	-
Opsonization	+	-	+++	*	++	+	+	-
Sensitization for killing by NK cells	-	-	++	-	++	-	-	-
Sensitization of mast cells	-	-	+	-	+	-	-	+++
Activates complement system	+++	-	++	+	+++	-	+	-
Distribution	IgM	IgD	IgG1	IgG2	IgG3	IgG4	IgA	IgE
Transport across epithelium	+	-	-	-	-	-	+++ (dimer)	-
Transport across placenta	-	-	+++	+	++	+/-	-	-
Diffusion into extravascular sites	+/-	-	+++	+++	+++	+++	++ (monomer)	+
Mean serum level (mg ml ⁻¹)	1.5	0.04	9	3	1	0.5	2.1	3 × 10 ⁻⁵

Figure 9-19 Immunobiology, 7ed. (© Garland Science 2008)

Строение иммуноглобулинов разных классов

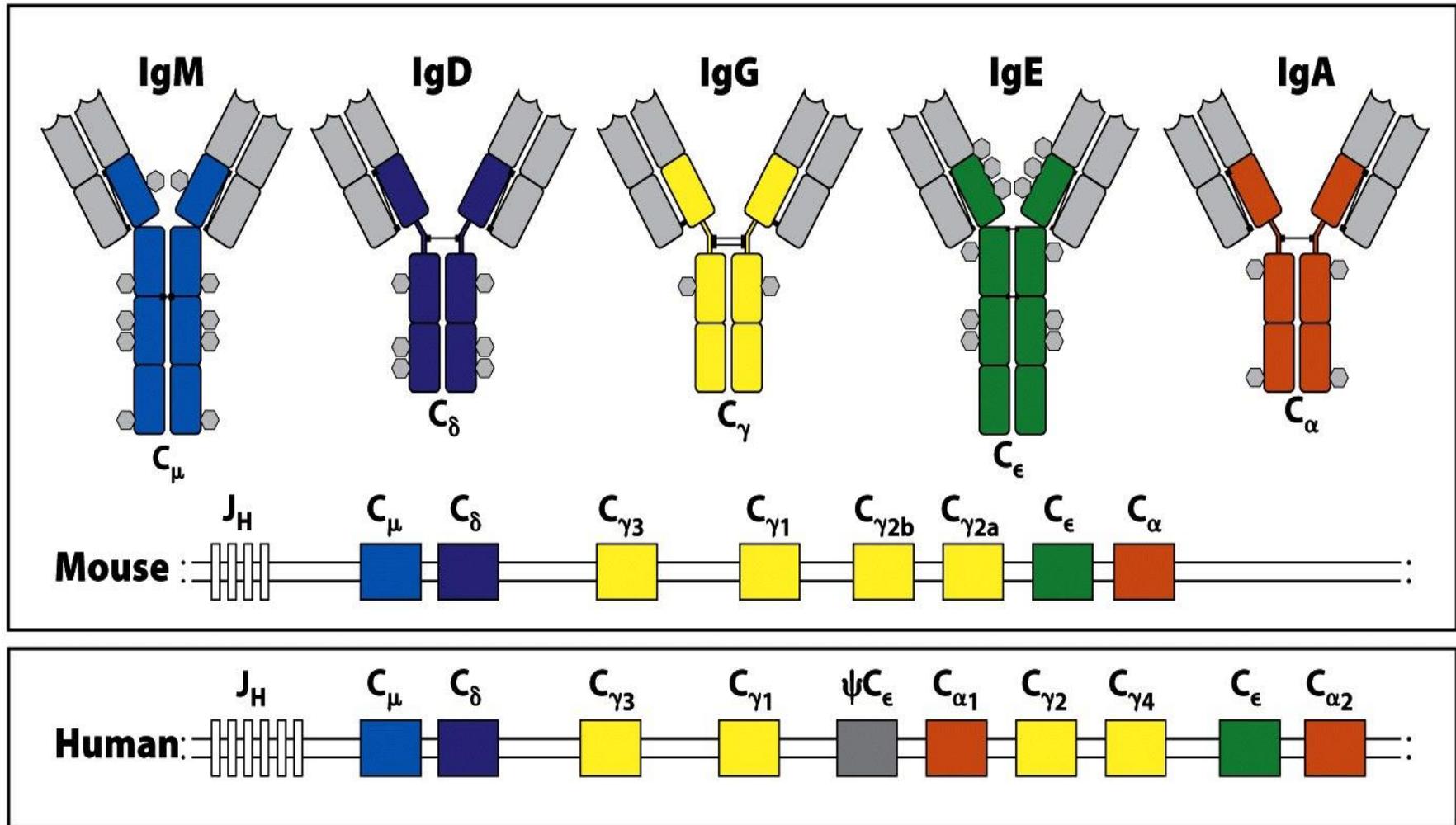


Figure 4-17 Immunobiology, 7ed. (© Garland Science 2008)

Строение молекул IgM и секреторного IgA

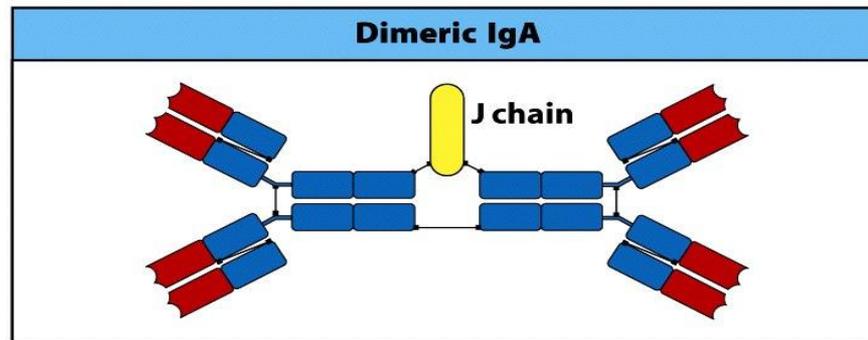
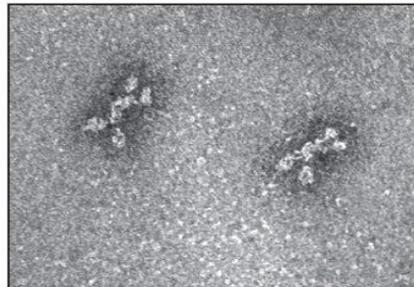
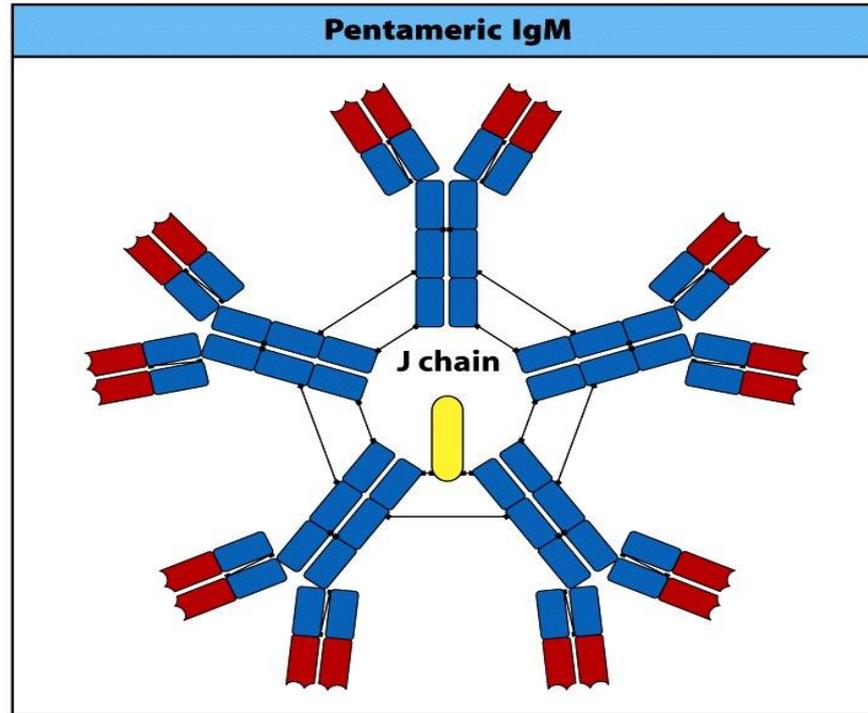
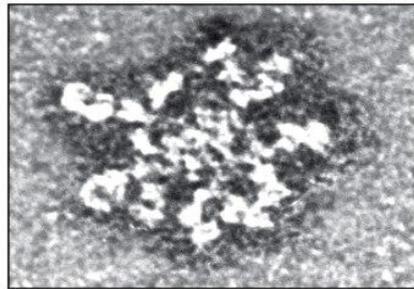


Figure 4-20 Immunobiology, 7ed. (© Garland Science 2008)

Источники разнообразия иммуноглобулинов

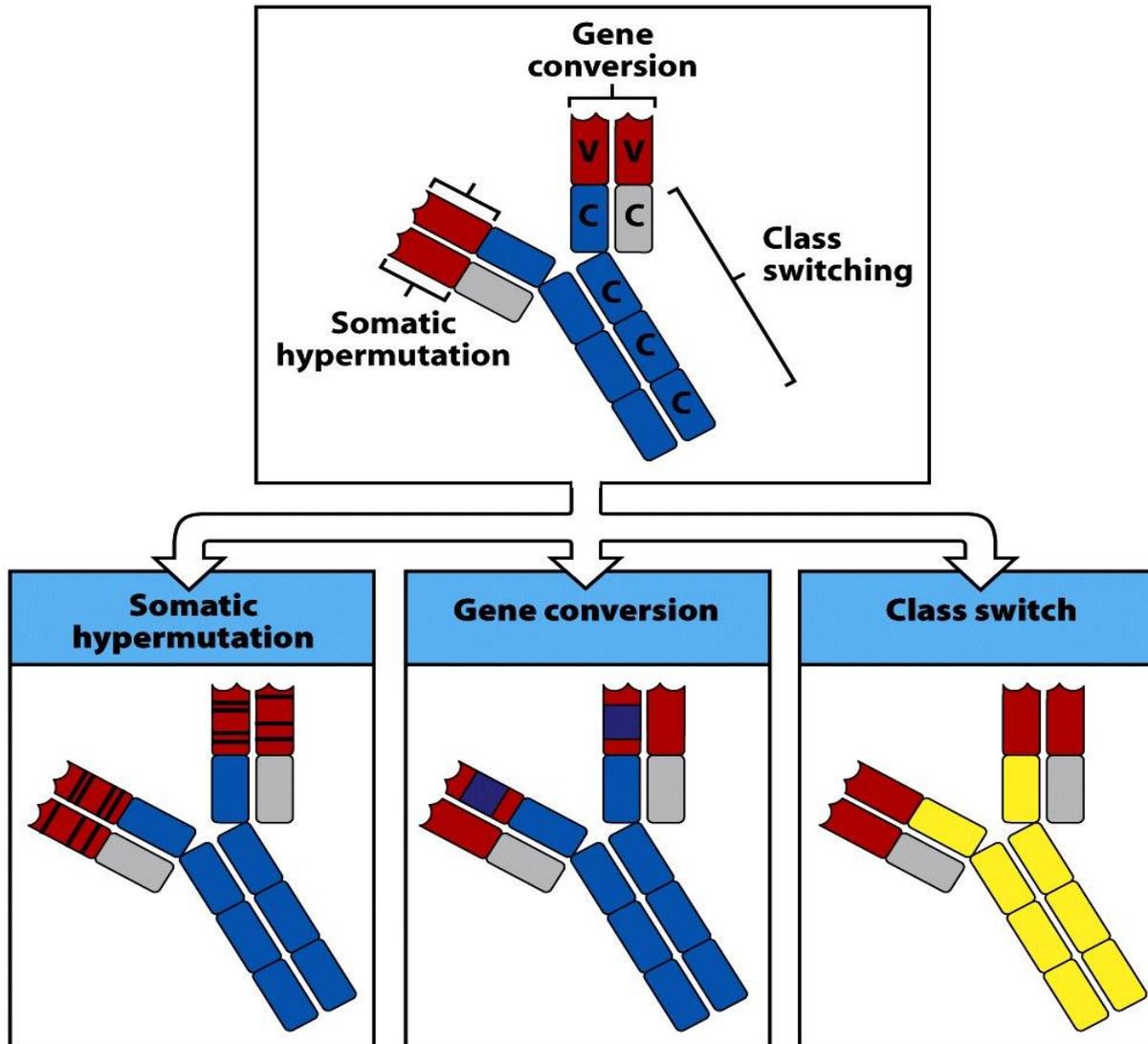


Figure 4-21 Immunobiology, 7ed. (© Garland Science 2008)

Реакции антиген-антитело

Связывание антигена и антитела

Связывание АГ с АТ

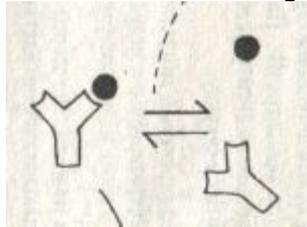
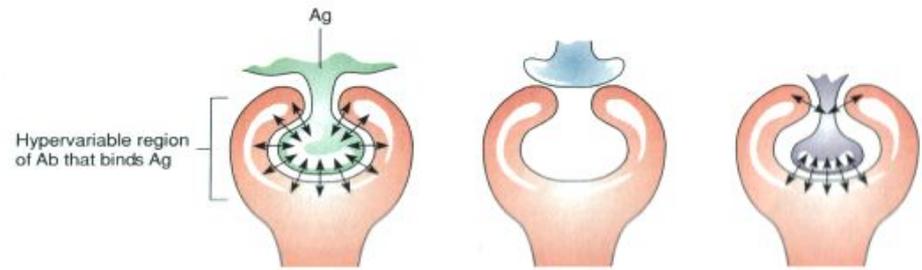
основывается на

тесном трехмерном

контакте. АГ-связывающий

участок представляет собой щель размером $3 \times 1 \times 1$ нм.

Связывание обеспечивается за счет водородных, гидрофобных, электростатических и Ван-дер-Ваальсовых межмолекулярных сил.



Аффинитет антител выражается константой равновесия.

$K = 10^3$ - низкоаффинные антитела

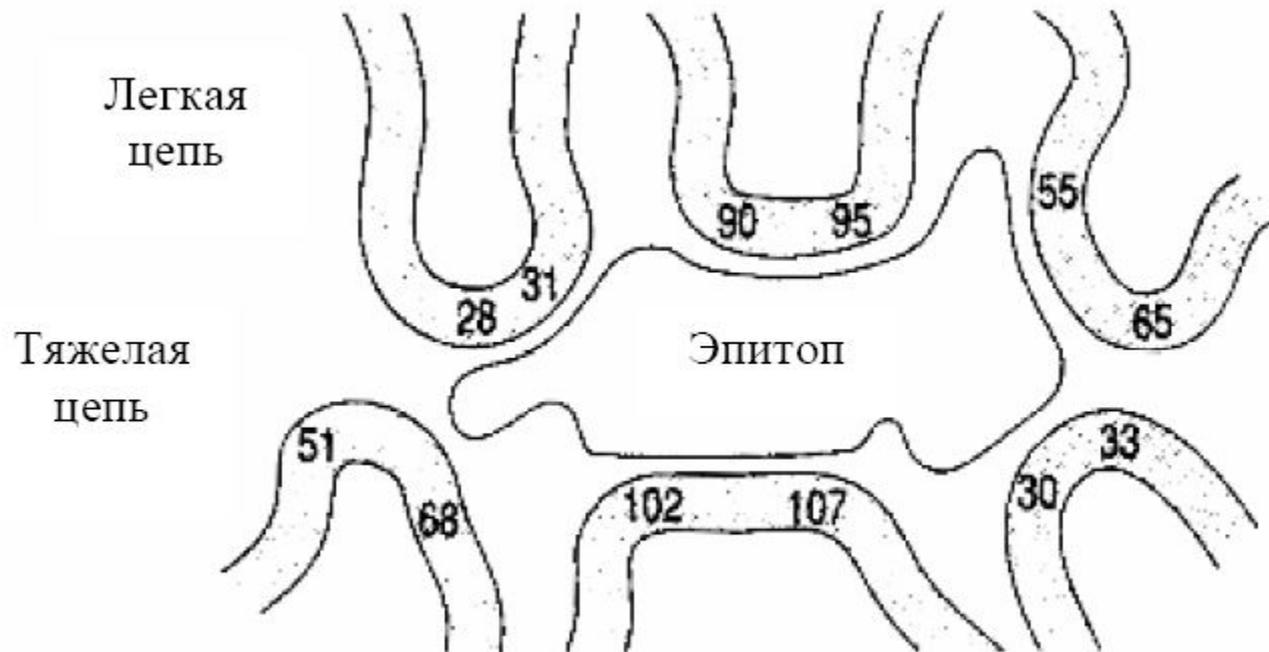
$K = 10^{10}$ - высокоаффинные антитела

Аффинитет	
$K =$	$\frac{[\text{Аб} \cdot \text{АГ}]}{[\text{Аб}] \times [\text{АГ}]}$

Авидность определяется числом АГ-
участков.

участков.

Взаимодействие антигенной детерминанты (эпитопа) с антигенсвязывающим участком молекулы антитела



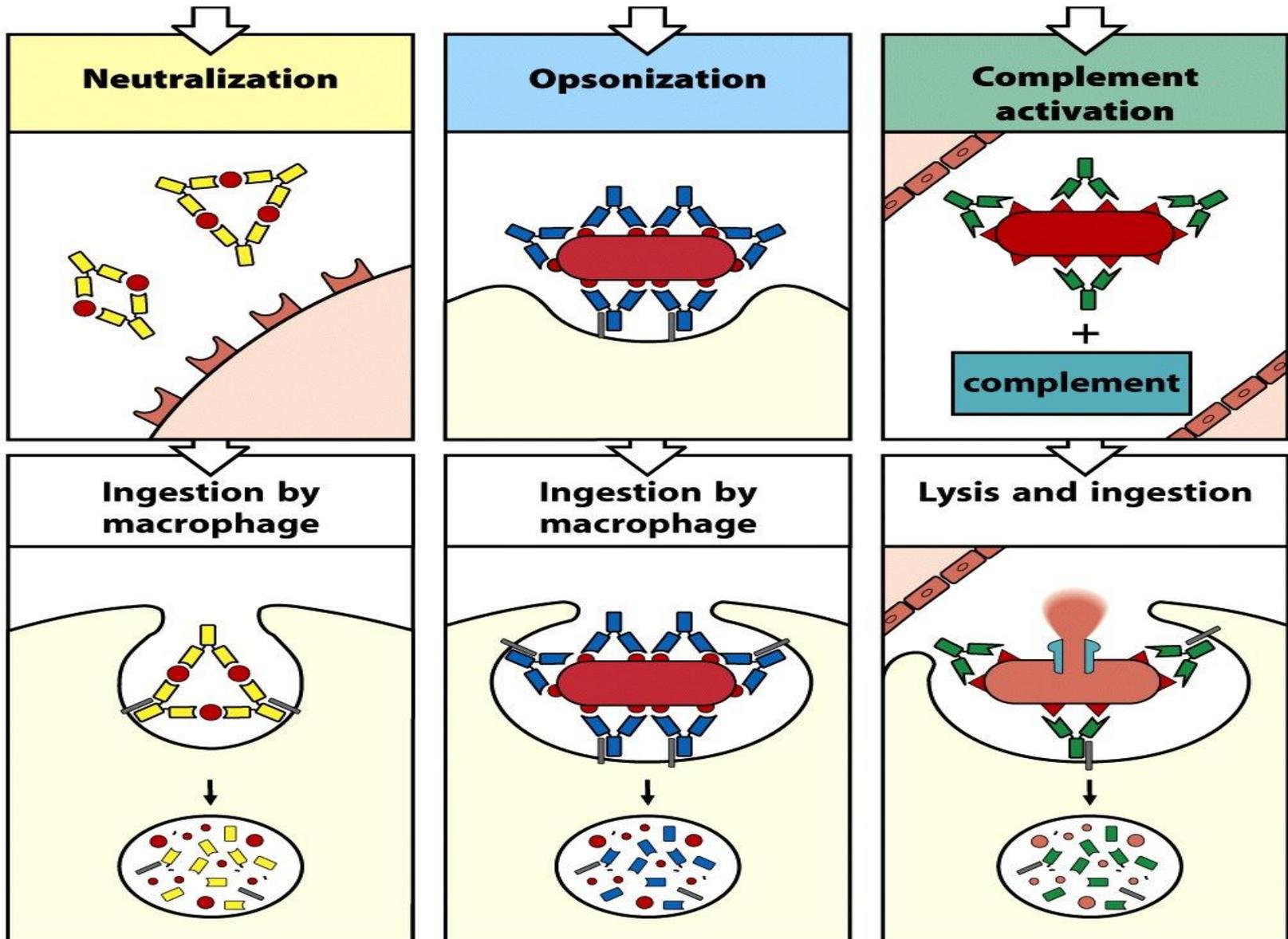


Figure 1-26 part 3 of 3 Immunobiology, 7ed. (© Garland Science 2008)

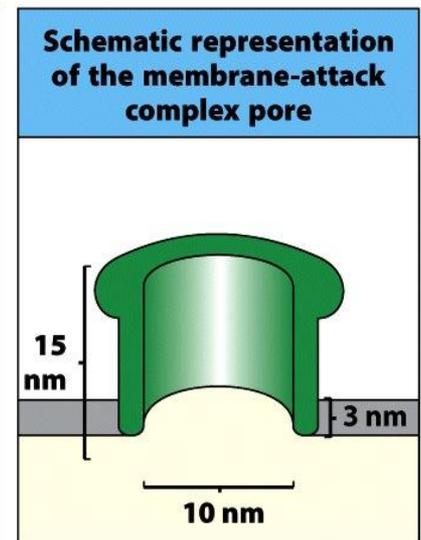
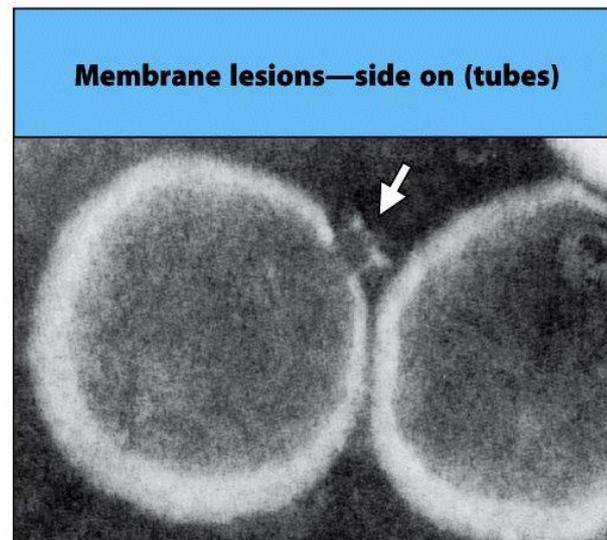
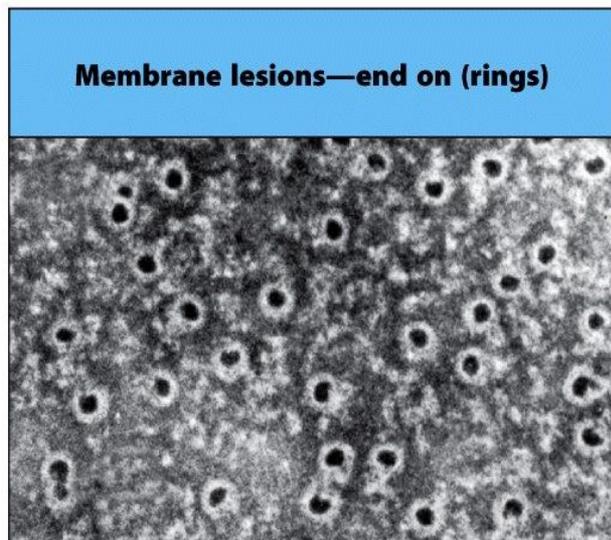
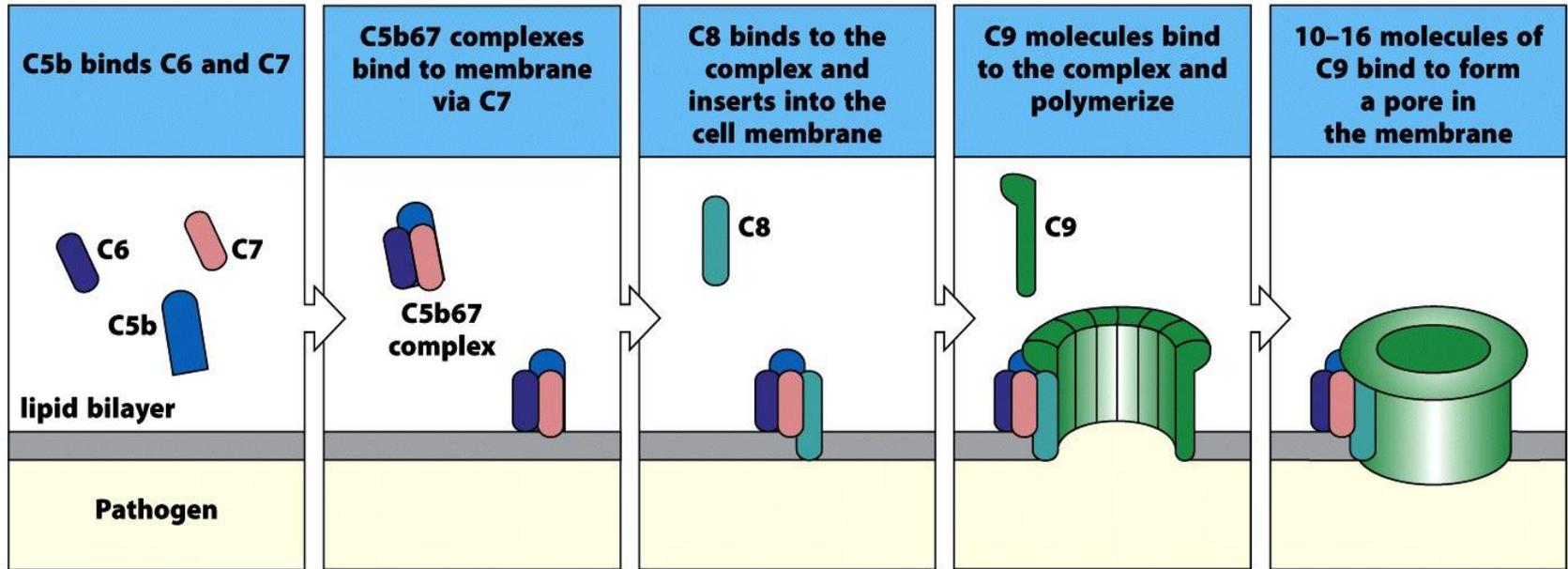


Figure 2-41 Immunobiology, 7ed. (© Garland Science 2008)

ПУТИ АКТИВАЦИИ КОМПЛЕМЕНТА

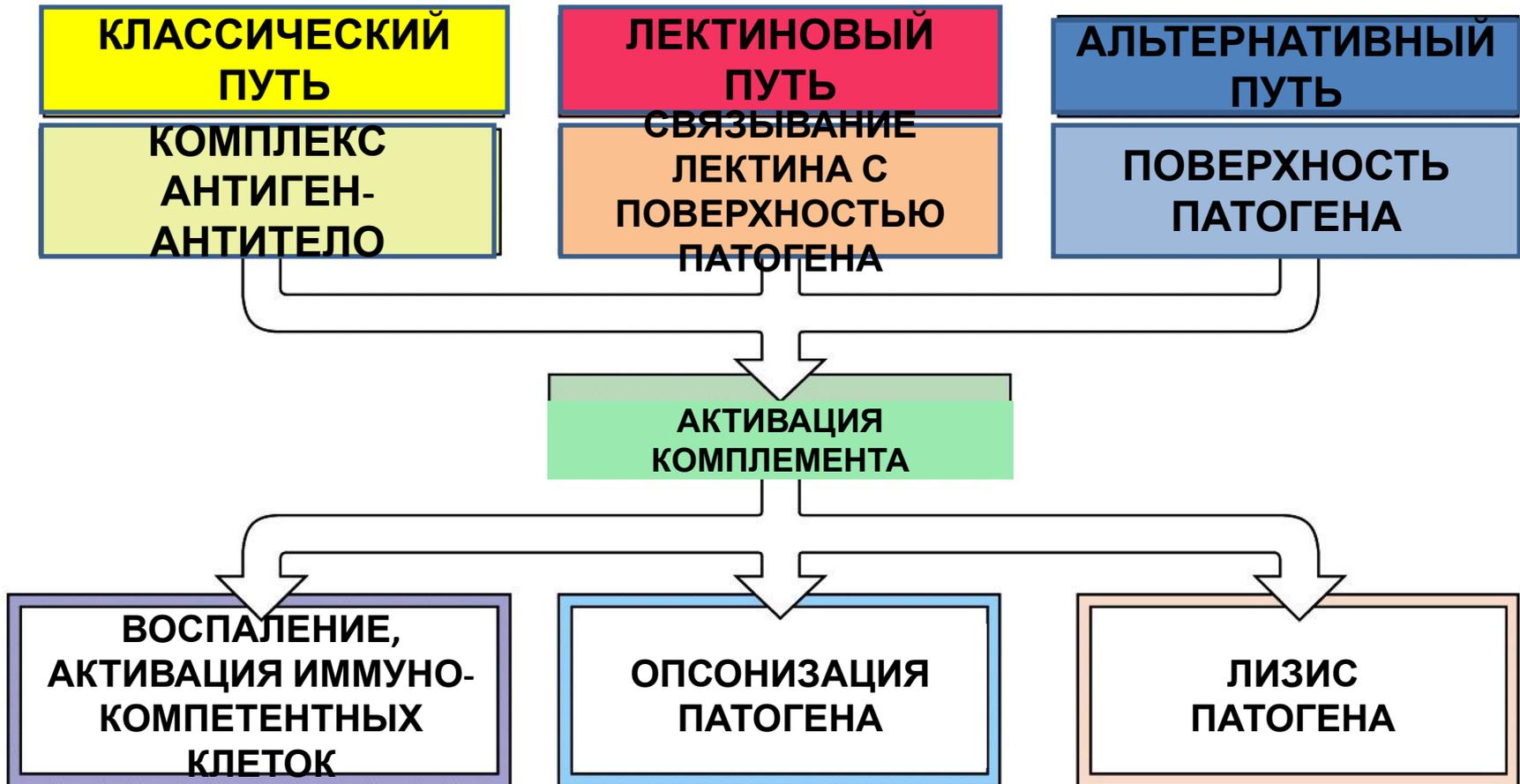


Figure 2-24 Immunobiology, 7ed. (© Garland Science 2008)

Молекулы главного комплекса гистосовместимости I и II классов

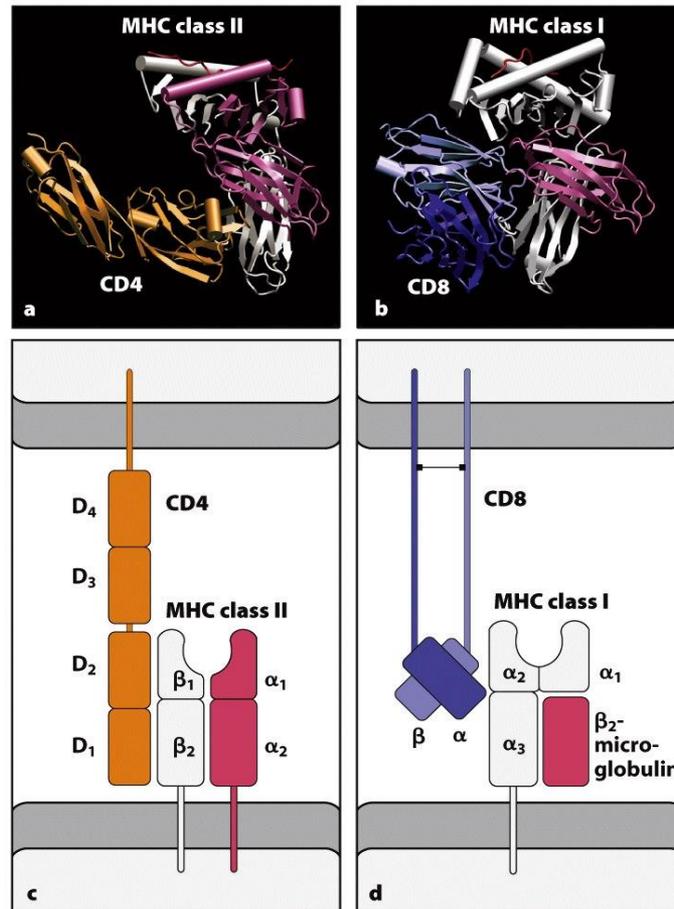


Figure 3-25 Immunobiology, 7ed. (© Garland Science 2008)

T-независимые антигены

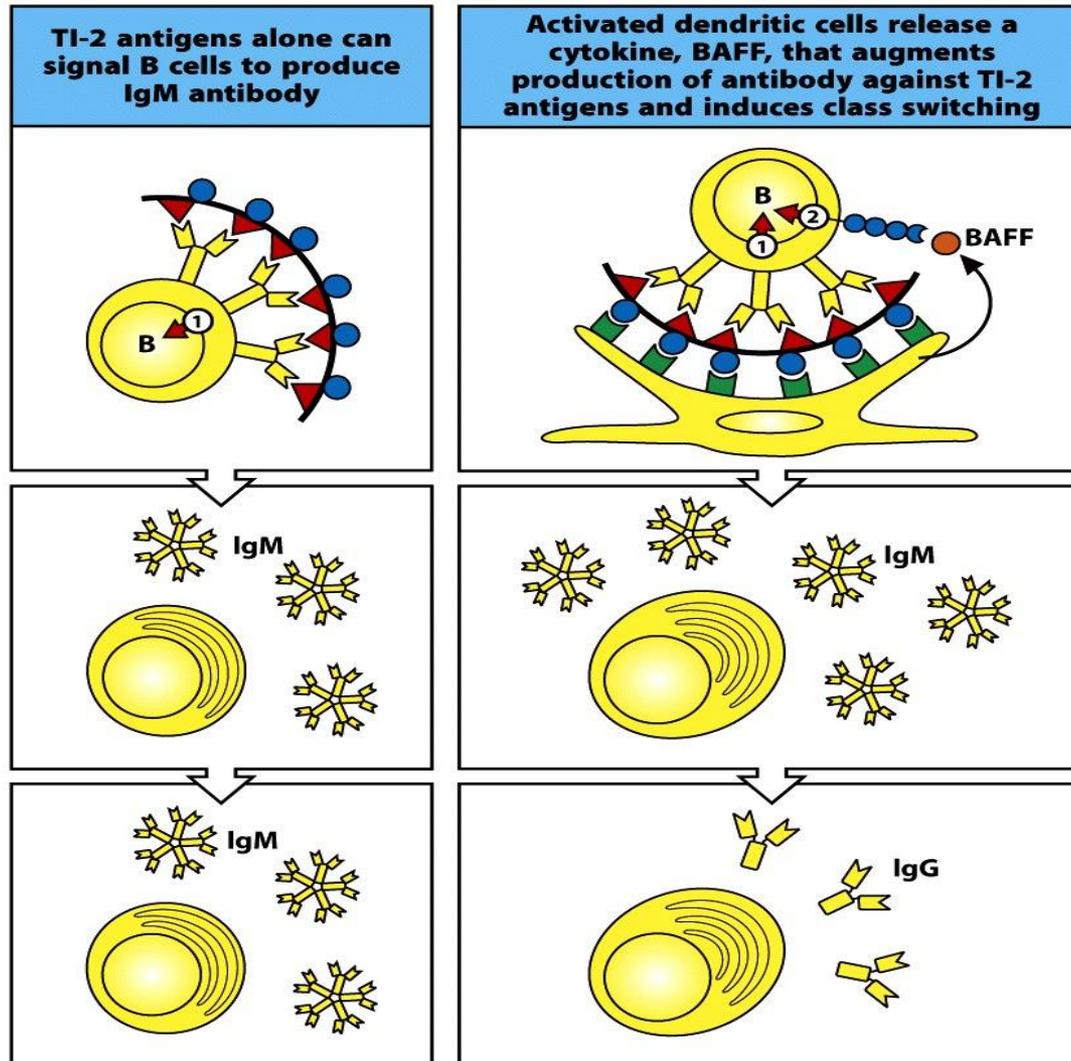


Figure 9-17 Immunobiology, 7ed. (© Garland Science 2008)

	TD antigen	TI-1 antigen	TI-2 antigen
Antibody response in infants	Yes	Yes	No
Antibody production in congenitally athymic individual	No	Yes	Yes
Antibody response in absence of all T cells	No	Yes	No
Primes T cells	Yes	No	No
Polyclonal B-cell activation	No	Yes	No
Requires repeating epitopes	No	No	Yes
Examples of antigen	Diphtheria toxin Viral hemagglutinin Purified protein derivative (PPD) of <i>Mycobacterium tuberculosis</i>	Bacterial lipopolysaccharide <i>Brucella abortus</i>	Pneumococcal polysaccharide <i>Salmonella</i> polymerized flagellin Dextran Hapten-conjugated Ficoll (polysucrose)

Figure 9-18 Immunobiology, 7ed. (© Garland Science 2008)

СВОЙСТВА IgE

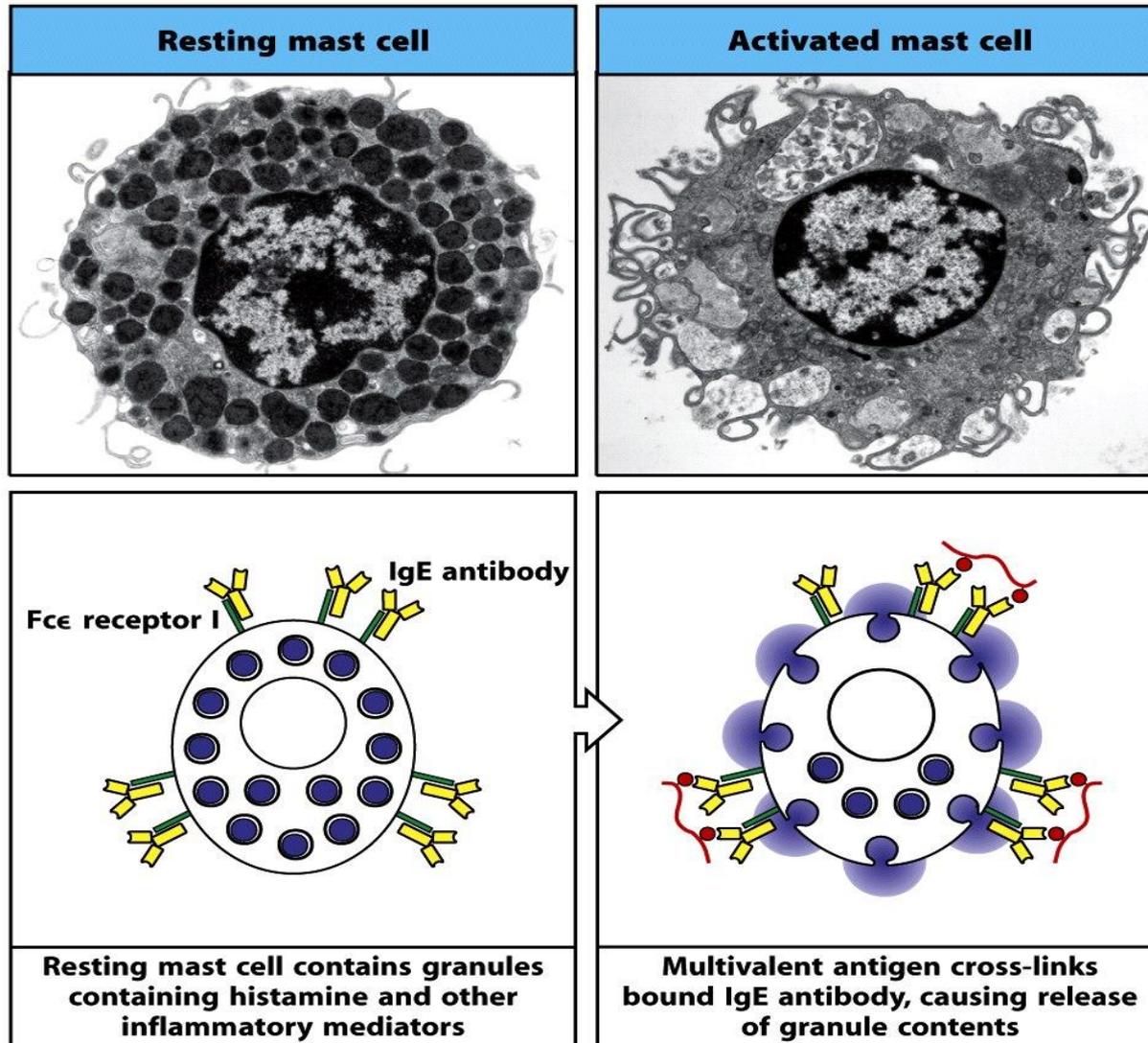


Figure 9-35 Immunobiology, 7ed. (© Garland Science 2008)

Первичный и вторичный иммунный ОТВЕТ

	Source of B cells	
	Unimmunized donor Primary response	Immunized donor Secondary response
Frequency of antigen-specific B cells	1:10 ⁴ – 1:10 ⁵	1:10 ² – 1:10 ³
Isotype of antibody produced	IgM > IgG	IgG, IgA
Affinity of antibody	Low	High
Somatic hypermutation	Low	High

Figure 10-18 Immunobiology, 7ed. (© Garland Science 2008)